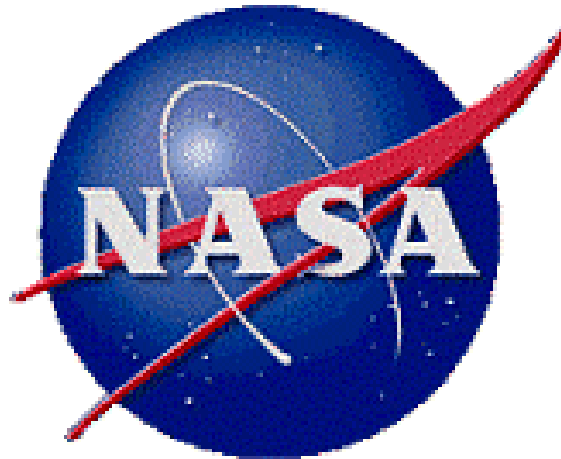
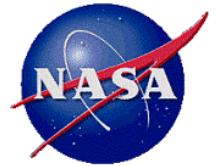


# **Safety and Mission Assurance Review and Assessment Division Programmatic Audit and Review**

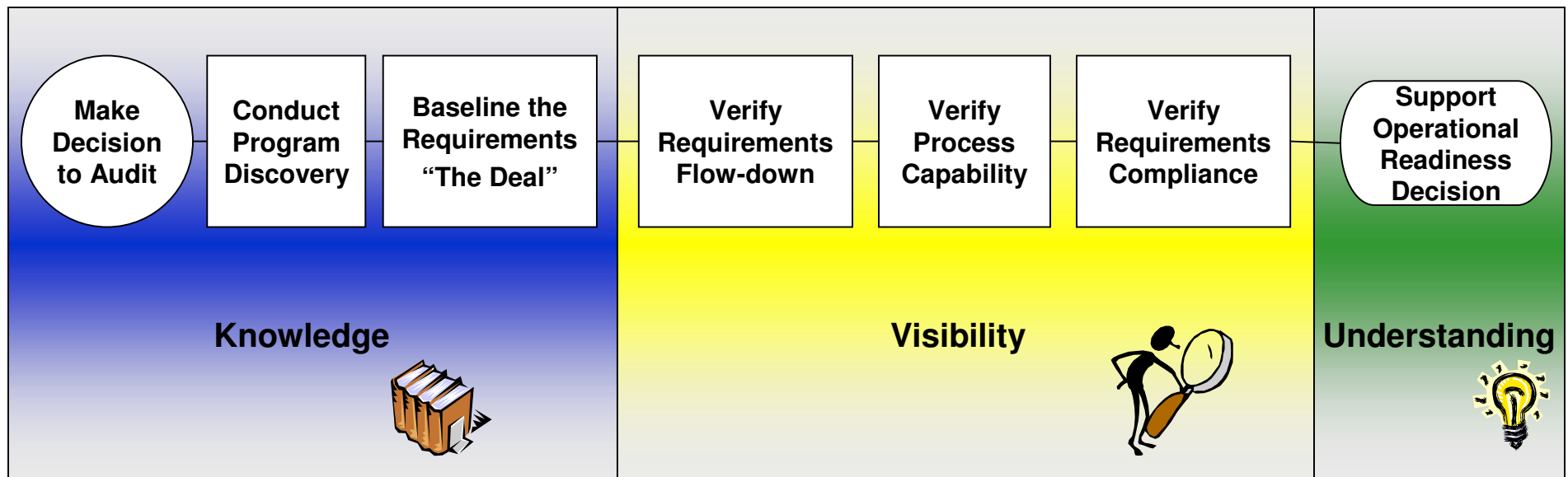
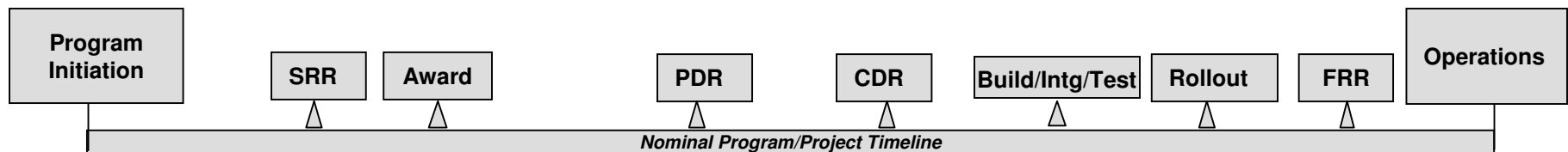


**Compliance Verification Workshop  
Boulder, Colorado  
September 14-16, 2004**

# Approach



- Develop **Knowledge** of Program SMA requirements
  - Gain **Visibility** into SMA capability and compliance levels
  - Communicate **Understanding** of associated *Residual Risks* to support *Operational Readiness decisions*



# Make Decision To Audit



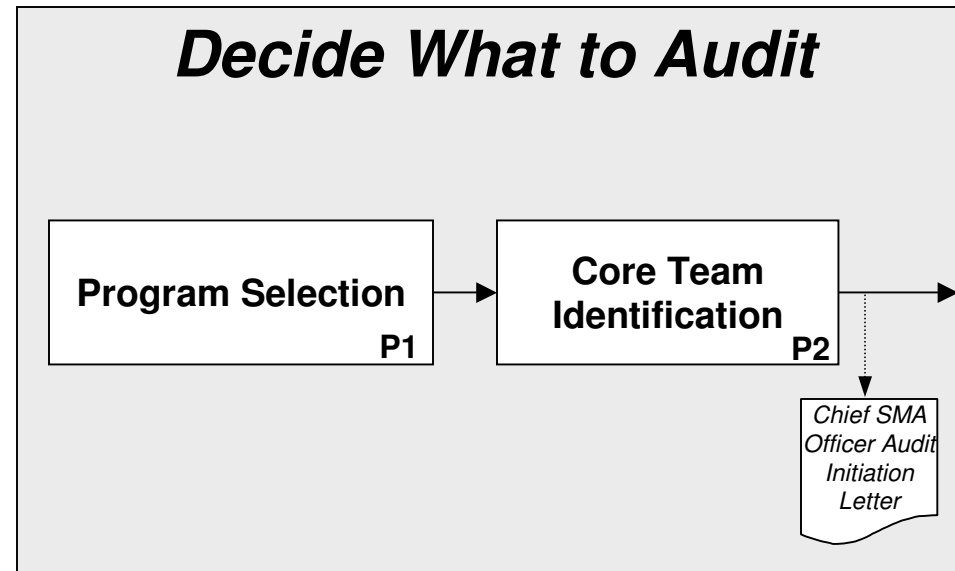
## ***Sub-processes:***

### **P1. Program Selection**

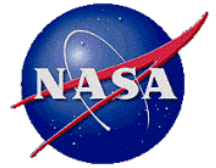
- By Request
- By Selection Logic
- By Direction

### **P2. Core Audit and Review Team Identification**

- Program/project type, development phase, criticality, etc, drives choice of audit team
- Core Team provides sustained audit process support
  - **Dynamic, evolving nature**
- SMEs provide additional support as needed for specific audits



# Conduct Program Discovery



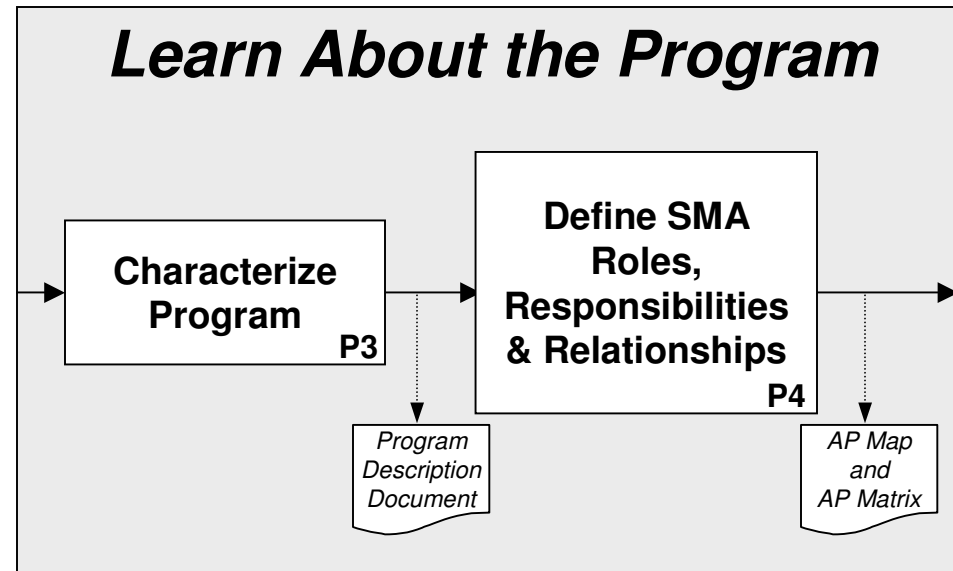
## ***Sub-processes:***

### **P3. Characterize Program**

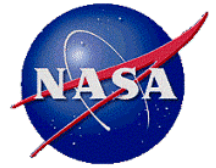
- Gather information
  - Documentation Review
  - Technical Interchange Meetings
  - Develop Program Description Document

### **P4. Define SMA Roles, Responsibilities and Relationships**

- Develop Assurance Process Map and Assurance Process Matrix
- Maintain Assurance Process Map and Matrix to track the evolving nature of program and to inform Chief S&MA Officer



# Baseline the Requirements



## Sub-processes:

### P5. Requirements Filtering

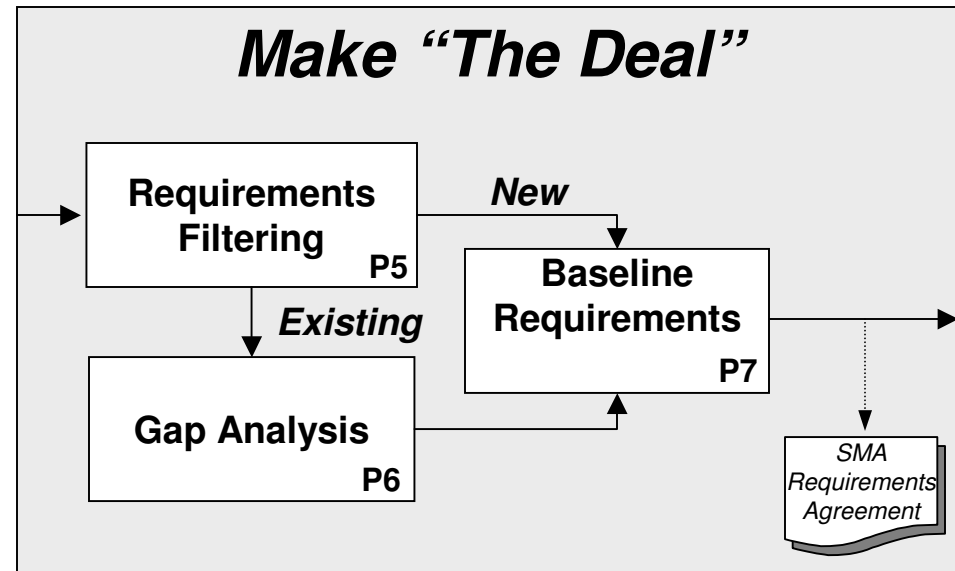
- New Programs – Core Team identifies program-specific Agency SMA requirements

### P6. Gap Analysis

- Existing Programs – Core Team performs requirements gap analysis

### P7. Baseline Requirements

- Program-specific SMA requirements for new programs
- Deltas to SMA requirements based on existing program contract requirements



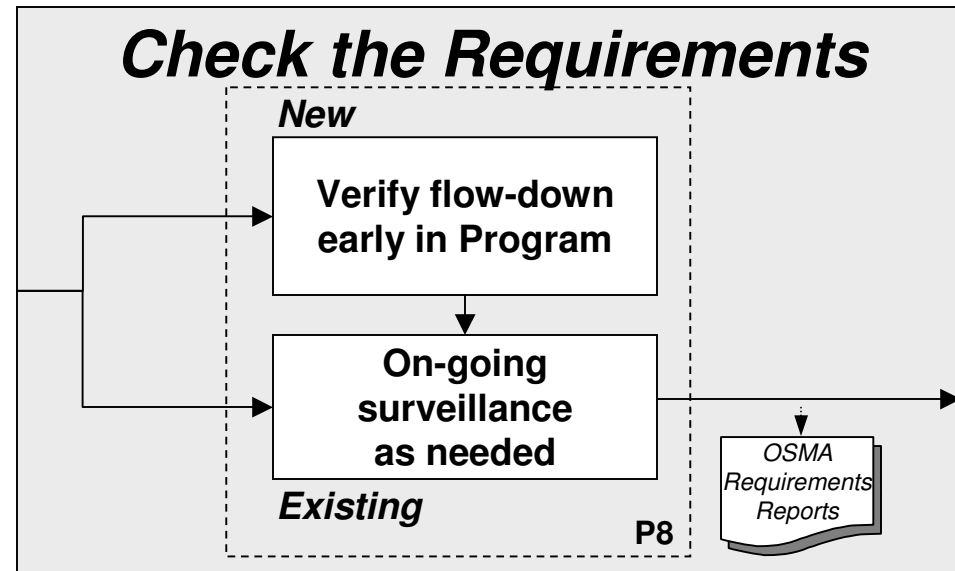
# Verify Requirements Flow-down



## Sub-processes:

### P8. Verify Requirements Flow-down

- Verify flow-down of baseline SMA requirements to all levels
  - Conduct during the SRR/RFP phase for new programs
- Conduct surveillance of SMA requirements flow-down as needed for existing programs
  - Existing contractual SMA requirements
  - Deltas to baseline requirements
  - Deltas to contractors and subcontractors



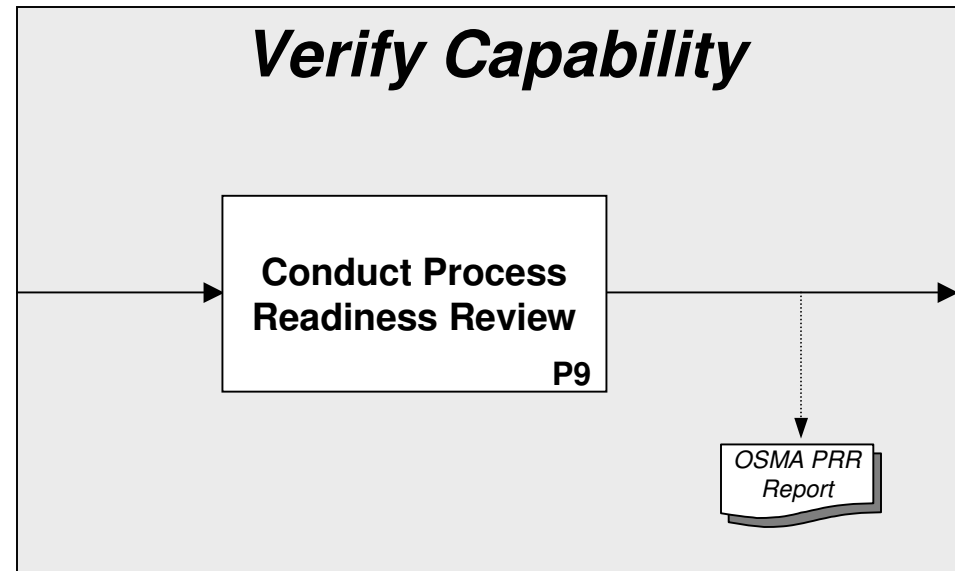
# Verify Process Capability



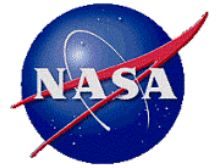
## Sub-processes:

### P9. Process Readiness Review

- Conduct between contract award and PDR for new programs
- Conduct as appropriate for existing programs
- Assess for each Implementing Organization - ***Is there sufficient “water pressure?”***
  - Staffing
  - Skill Mix
  - Tools
  - Funding
  - Training/certifications



# Verify Requirements Compliance



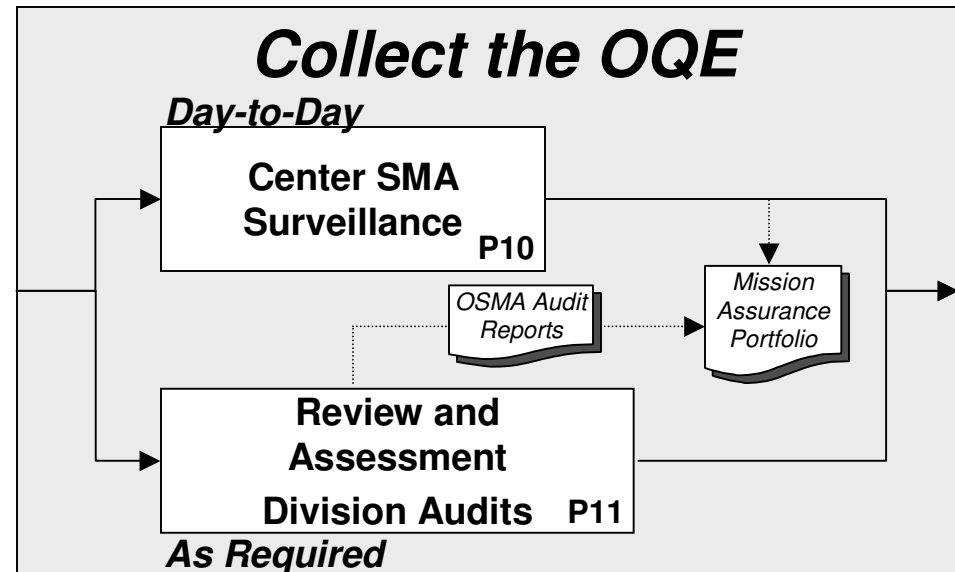
## Sub-processes:

### P10. Center SMA Surveillance

- New and existing programs:  
Center SMA ongoing support to identify & track Objective Quality Evidence

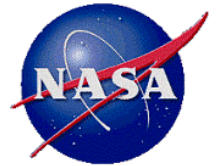
### P11. OSMA Review and Assessment Division Audits

- New and existing programs:  
Periodic verification of implementation of applicable requirements set
- Leverage other Independent Assessments (IAs) to increase effectiveness & decrease overlap
  - NESC, IPAD, IV&V, ASAP, etc.
  - IPAO MOU





# Support Operational Readiness



## P12. Programmatic Audit & Review Input to ORR

- Present Residual Risk Profile to Chief Safety and Mission Assurance Officer
- Summarize audit / review findings regarding requirements:
  - **Baseline**
  - **Flow-down**
  - **Implementation Processes**
  - **Compliance**
- Present any requirements issues that deserve attention

### *Brief Chief S&MA Officer*

Support  
Operational  
Readiness  
Decision

P12

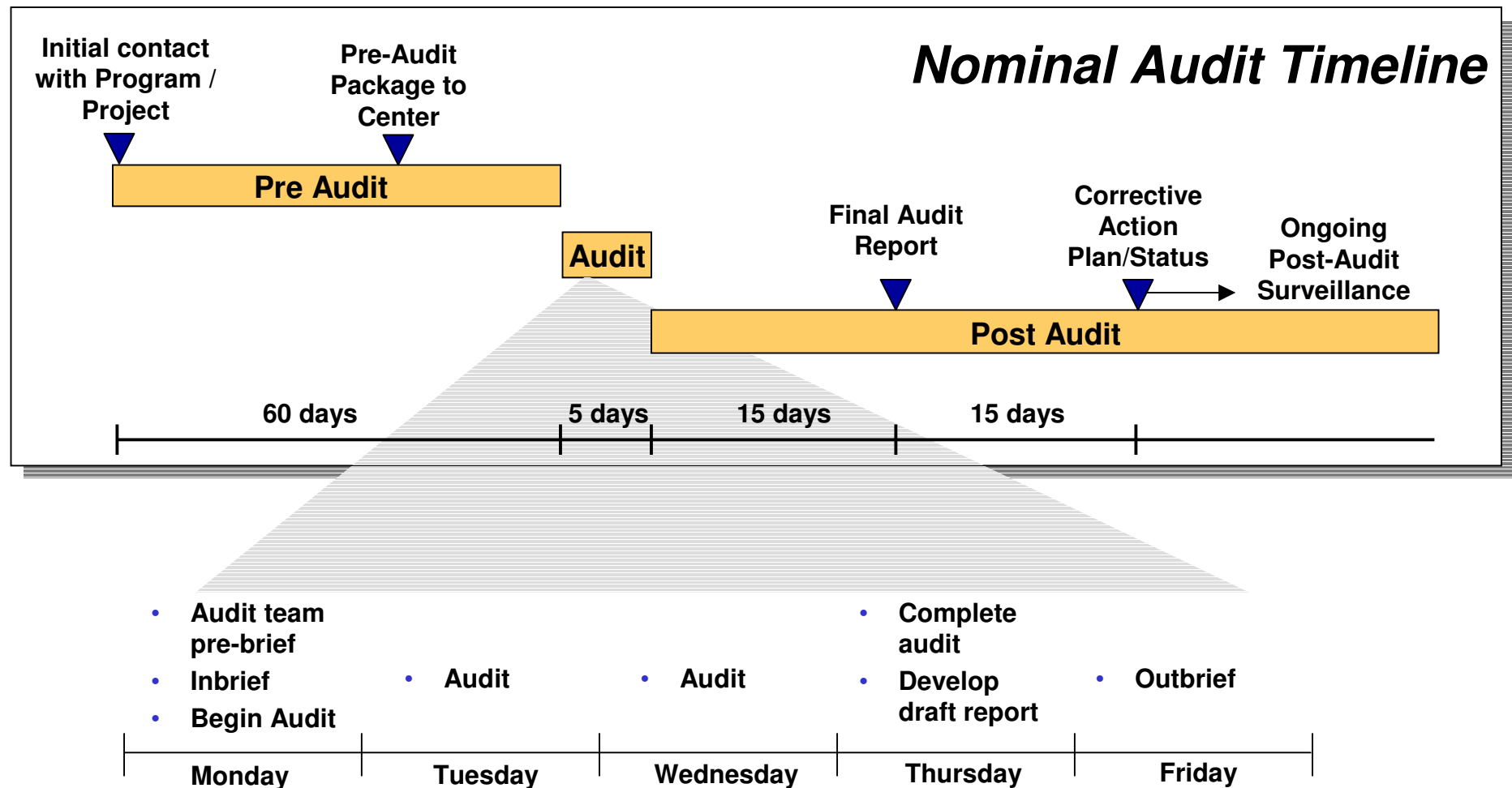
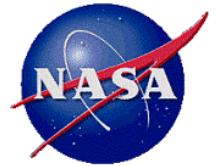
### *ORR Risk Summary*

Assurance Elements	Program	Center S&MA	NESC	PA&R	...
SMA Req. Compliance	0	0	1	3	-
Changes	0	0	-	-	-
Technical Issues	1	1	5	-	-

Programmatic Audit and Review represents one input to the overall program / project risk profile



# Programmatic Audit & Review (PA&R) Audit Timeline



# **Programmatic Audit & Review (PA&R) Development**

---



## **“Building the Boat”**

- **Program / Project selection criteria process**
- **Audit team building process**
- **Assurance Process Map and Matrix development guides**
- **Baseline requirements development and verification**
- **Requirements gap analysis and risk assessment**
- **Audit and surveillance guides**
- **Risk characterization and risk profile input to SMA ORR**

# **Programmatic Audit & Review (PA&R) Implementation**

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## **“Sailing the Boat”**

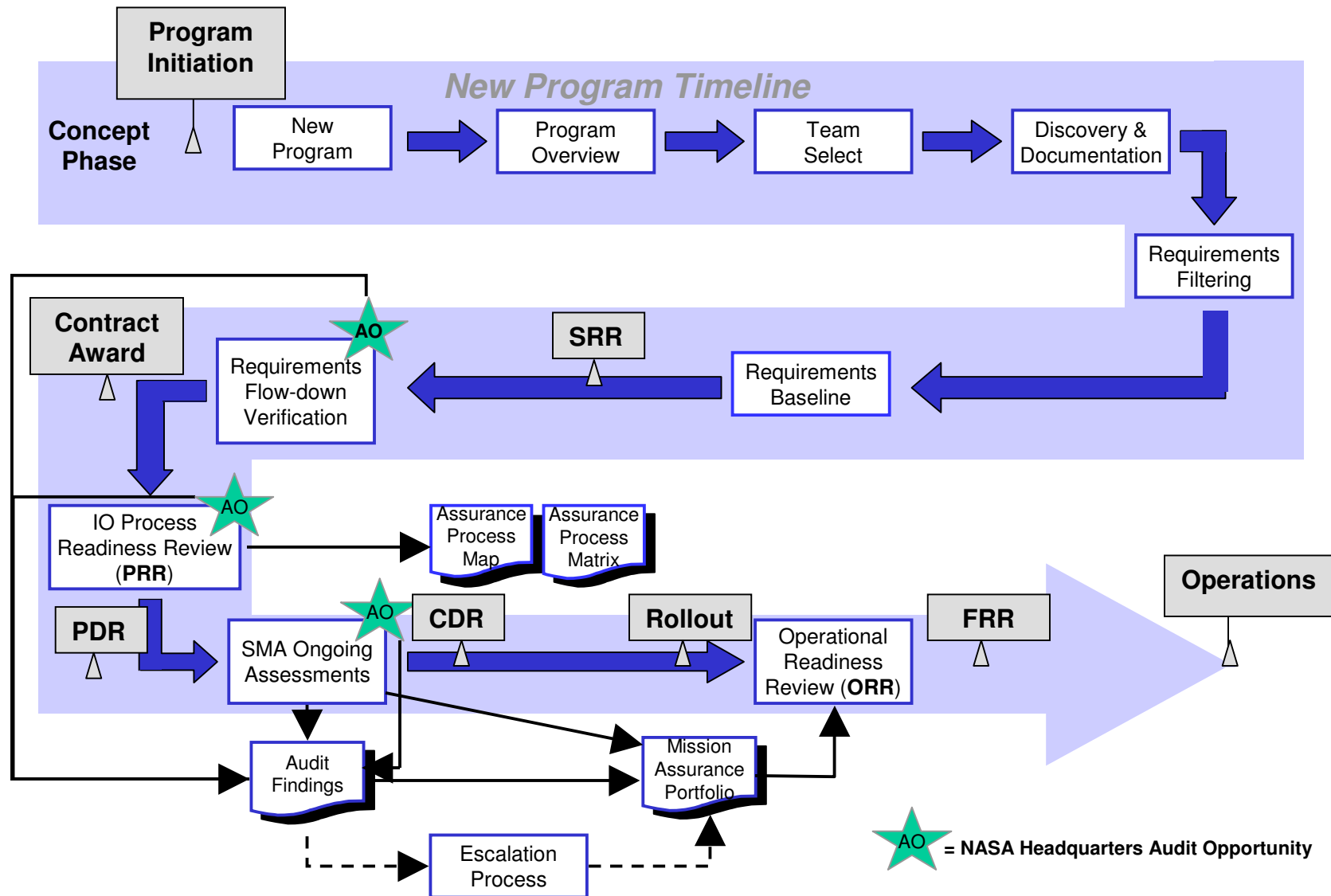
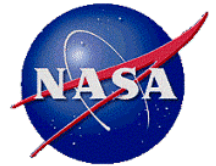
- **Space Shuttle Program / USA Ground Ops – ongoing**
- **KSC / SMA Expendable Launch Vehicle -- ongoing**
- **Hubble Space Telescope / Robotic Servicing Mission**
- **International Space Station**
- **Exploration Systems / Crew Exploration Vehicle**



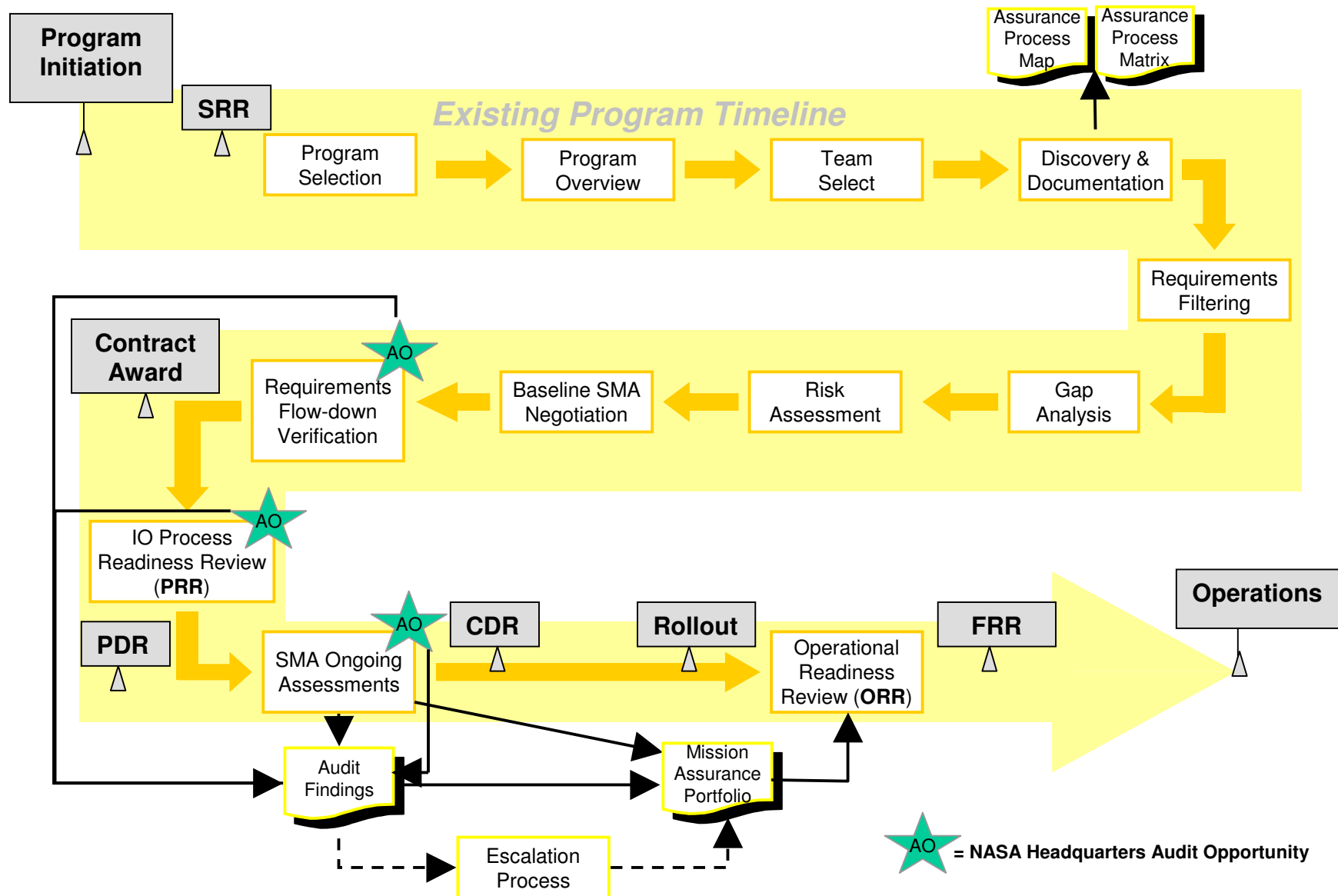
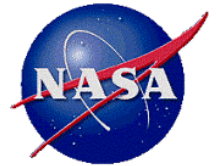
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## DETAILED PROCESS SLIDES

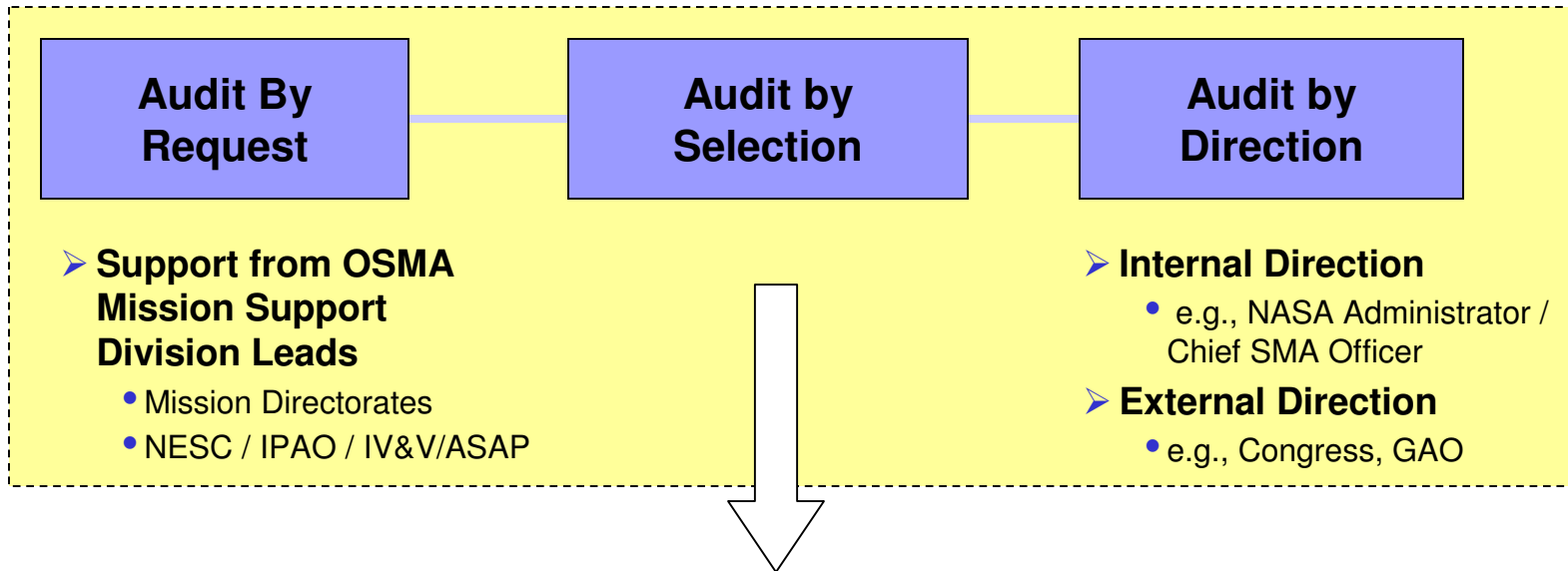
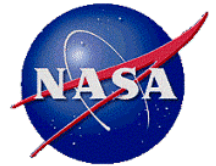
# PA&R Process Flow (New Program)



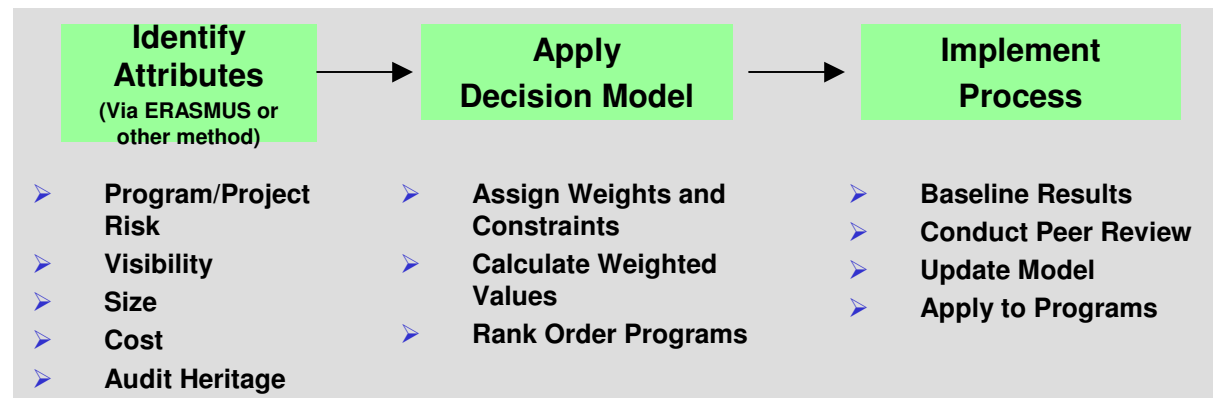
# PA&R Process Flow (Existing Program)



# P1. Program Selection

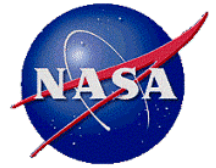


## *Apply Structured Logic to Selection Process*





## P2. Core Audit Team Identification



### ➤ Programmatic scope drives choice of audit and review team

- Core Audit and Review Team provides long term, sustaining support
  - Dynamic, evolving nature
- Team Lead – Review and Assessment Division,  
Team Deputy – Center SMA
- Support Services Contractors
  - ARES, BAE Systems, Perot Systems (“corporate” memory)
- Additional SME Support,
  - e.g., other Center SMAs, Chief Engineer, Engineering and Tech Directorates, Navy SUBSAFE QA, etc.

**Core Team:**  
Operates  
over  
Program  
Lifecycle

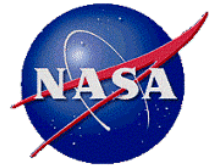
**Additional  
SMEs:**  
Augment Core  
Team as needed

**Review & Assessment Division Interfaces & Interactions**

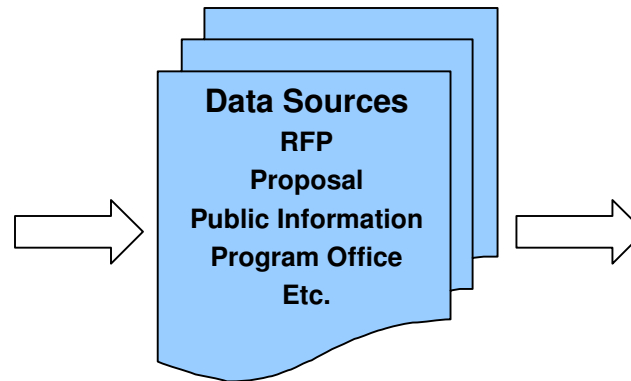
	MSD	SARD	Pgm Line	Center Directorate	Center SMA	IA	SAC	ITA	NESC	IV&V	IPAD	OHMS	OMS
<b>Institutional / Operational Audit</b>	PAT	PAT			PAT	PAT			PAT	PAT		OQE PAT	OQE PAT
<b>Programmatic Audit</b>	PAT	PAT OQE	OQE	PAT /OQE	OQE PAT	PAT FPR	Supl. OQE	TBD	PAT	PAT	OQE PAT		
<b>Operational Readiness Review</b>	Co- Lead	OQE	OQE	OQE	OQE	TA	Supl. OQE	TBD	TA	TA	TA		
<b>Special Projects &amp; Benchmarking</b>	PAT	PAT	Cust.		PAT	TA		TBD	PAT	PAT			



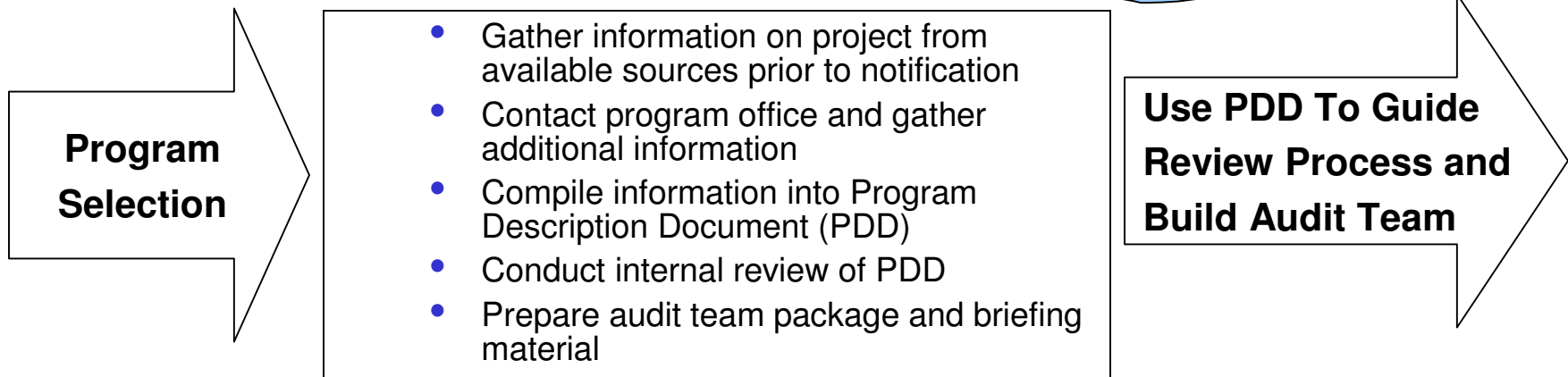
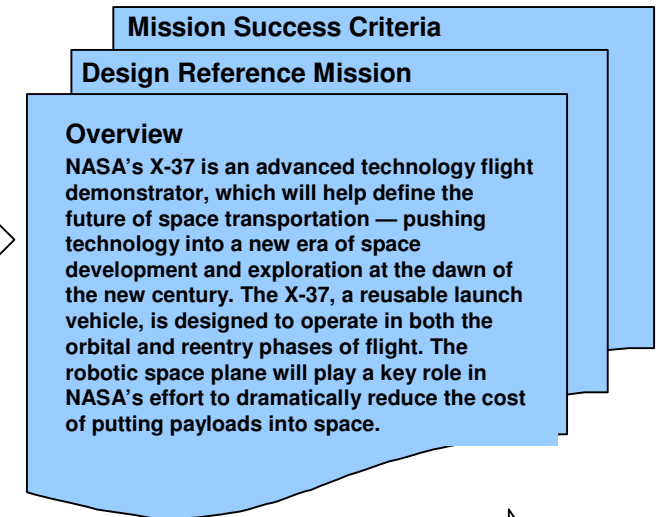
# P3. Characterize Program



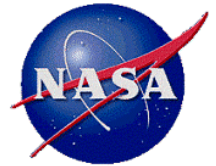
## Example of X-37 Selection



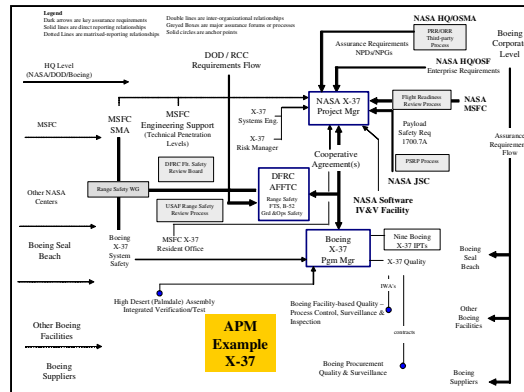
## Program Description Document



# P4. Define SMA Roles, Responsibilities and Relationships



## Center SMA Identifies Contract Participants and Accountability for SMA Processes



Notional Assurance Process Map

	Program SMA	Center SMA	IA	NEEC	WV	OV Acft	Crew	Minority Options
Sys Eff Prog Plan	John Smith OSFC (000) 100-1000				John Doe WV (000) 100-1000	Tim Johnson JSC (000) 100-1000		
QA Requirements	John Smith JSC (000) 100-1000			Leslie Dean MSPC (000) 100-1000	Carolyn Roberts HQ (000) 100-1000			NEPS Option
Hardware Design & Engineering	Bill Johnson JSC (000) 100-1000	Gary Johnson JSC (000) 100-1000	Trent Carverbaugh JSC (000) 100-1000	John Doe NEEC (000) 100-1000	Jim King JSC (000) 100-1000	Tom Feltman JSC (000) 100-1000		
Design Verification and Test	Robert Thompson MSPC (000) 100-1000	William Wright MSPC (000) 100-1000	Don Knight KSC (000) 100-1000	John Doe NEEC (000) 100-1000	Jane Doe WV (000) 100-1000			
Software Verification and Test	Arnie Baker MSPC (000) 100-1000	William Wright MSPC (000) 100-1000	Don Knight KSC (000) 100-1000	John Doe NEEC (000) 100-1000	Jane Doe WV (000) 100-1000			
Production	John Smith JSC (000) 100-1000					Tim Johnson JSC (000) 100-1000		
Production Test	John Smith OSFC (000) 100-1000	Gail Winters JSC (000) 100-1000			John Doe WV (000) 100-1000	Arnie Baker HQ (000) 100-1000	David Burmeister JSC (000) 100-1000	
Integrated Vehicle Assembly	John Smith JSC (000) 100-1000			Leslie Dean MSPC (000) 100-1000				
Integrated Vehicle Test	Bill Johnson JSC (000) 100-1000	Gail Winters JSC (000) 100-1000	Trent Carverbaugh JSC (000) 100-1000			Tim Johnson JSC (000) 100-1000		
Operations	Robert Thompson MSPC (000) 100-1000	William Wright MSPC (000) 100-1000	Don Knight KSC (000) 100-1000	John Doe NEEC (000) 100-1000	Jim King JSC (000) 100-1000	Tom Feltman JSC (000) 100-1000		
Spacecraft / Payload	Arnie Baker MSPC (000) 100-1000	William Wright MSPC (000) 100-1000	Don Knight KSC (000) 100-1000	John Doe NEEC (000) 100-1000				
Range / Pad Safety	John Smith JSC (000) 100-1000							

Notional Assurance Process Matrix

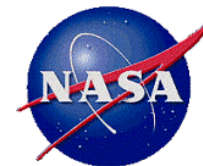
Previous Assurance Review Activities

Identify Accountable Organizations

Identify Organization Points of Contact



# P4. Define SMA Roles, Responsibilities and Relationships (cont.)



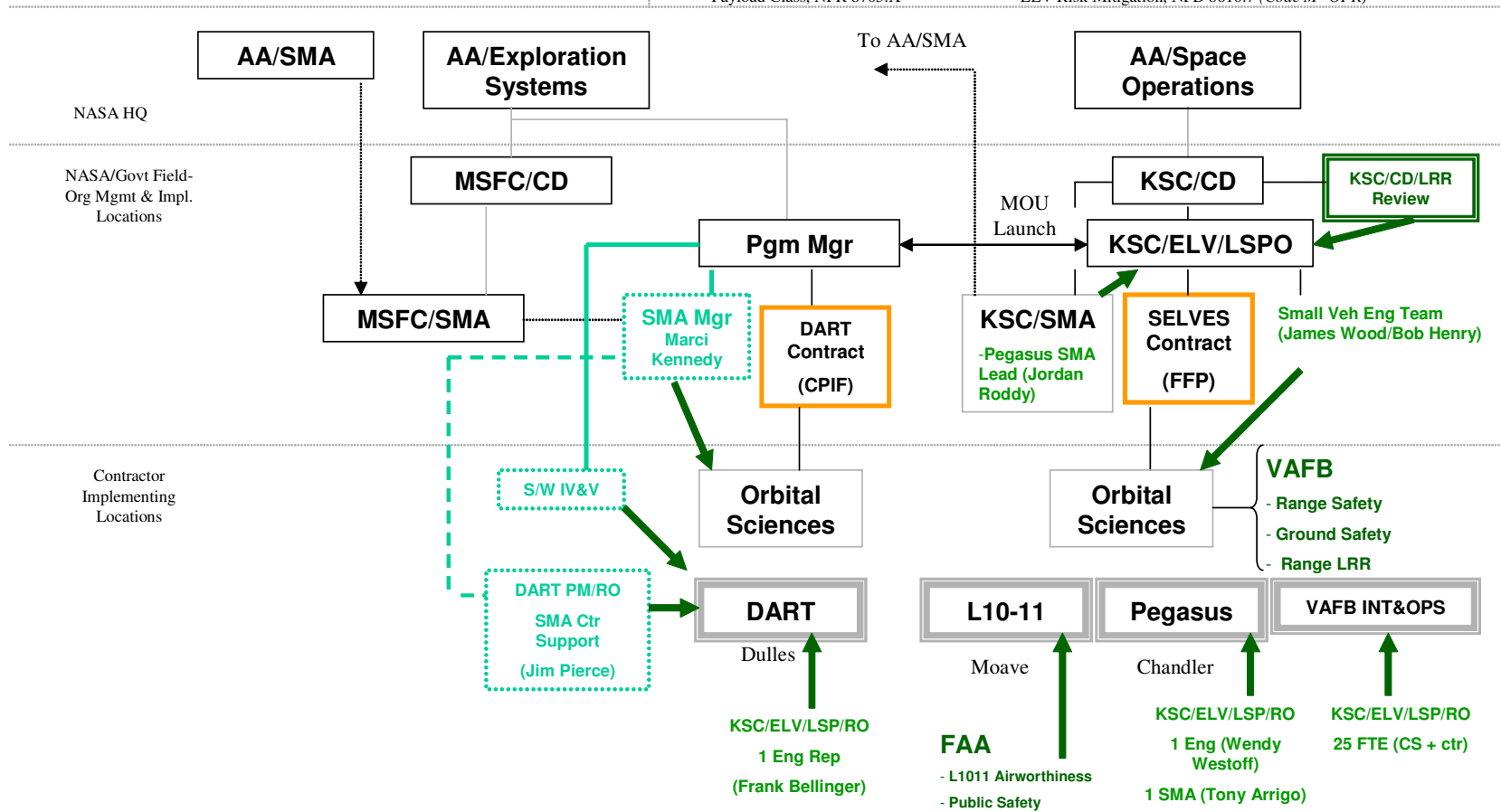
*DRAFT (8/10/04)*

*Assurance Process Map*

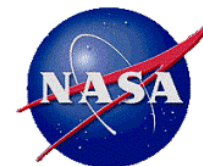
*DART PROGRAM*

## Selected NASA / Govt Requirements

- Orbital Debris, NPD 8710.3A
- Range Safety, NPR 8716.X
- DOD / RCC / **EWR 127-1**
- Inst / Launch Serv, NPD 8700.3
- Payload Class, NPR 8705.X
- ELV SMA R&R, NSS 8709.2
- ELV/Payload Safety Review, NSS 8719.8
- ELV Oversight, NPD 8610.23 (*Code M=OPR*)
- ELV Review, NPD 8610.24 (*Code M=OPR*)
- ELV Risk Mitigation, NPD 8610.7 (*Code M=OPR*)



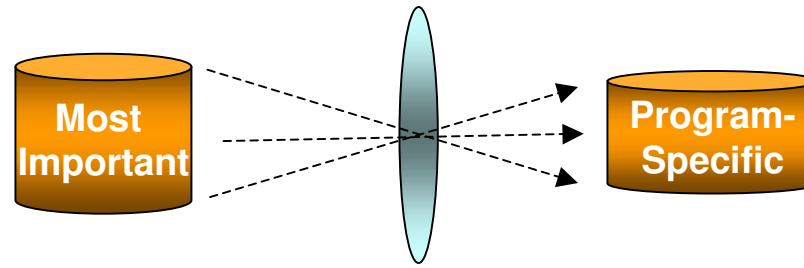
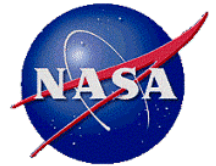
## P4. Define SMA Roles, Responsibilities and Relationships (cont.)



### Notional Mission Assurance Process Matrix

	Program SMA	Center SMA	IA	NESC	IV&V	QV Audit	Crew	Minority Opinions
<b>Sys Eff Prog Plan</b>	John Smith GSFC (xxx) xxx-xxxx				Jane Doe IV&V (xxx)xxx-xxxx	Ashley Anderson HQ (xxx) xxx-xxxx	Tim Johnson JSC (xxx) xxx-xxxx	
<b>QA Requirements</b>	John Smith KSC (xxx) xxx-xxxx			Leslie Dearn MSFC (xxx) xxx-xxxx	Carolyn Robard HQ (xxx) xxx-xxxx			NSRS Opinion
<b>Hardware Design &amp; Engineering</b>	Bill Johnson JSC (xxx) xxx-xxxx	Gary Jameson JSC (xxx) xxx-xxxx	Trent Cavanaugh JSC (xxx) xxx-xxxx			Jim King JSC (xxx) xxx-xxxx	Tom Feldman JSC (xxx) xxx-xxxx	
<b>Hardware Design Verificaiton and Test</b>	Sandra Evers JSC (xxx) xxx-xxxx			John Doe NESC (xxx) xxx-xxxx		Jim King JSC (xxx) xxx-xxxx	Tom Feldman JSC (xxx) xxx-xxxx	
<b>Software Design</b>	Robert Thompson MSFC (xxx) xxx-xxxx	William Wright MSFC (xxx) xxx-xxxx	Don Knight KSC (xxx) xxx-xxxx	John Doe NESC (xxx) xxx-xxxx	Jane Doe IV&V (xxx)xxx-xxxx			
<b>Software Verification and Test</b>	Anne Battan KSC (xxx) xxx-xxxx	William Wright MSFC (xxx) xxx-xxxx	Don Knight KSC (xxx) xxx-xxxx		Jane Doe IV&V (xxx)xxx-xxxx			
<b>Production</b>	John Smith JSC (xxx) xxx-xxxx						Tim Johnson JSC (xxx) xxx-xxxx	
<b>Production Test</b>	John Smith GSFC (xxx) xxx-xxxx	Gail Winters JSC (xxx) xxx-xxxx			Jane Doe IV&V (xxx)xxx-xxxx	Ashley Anderson HQ (xxx) xxx-xxxx	Tim Johnson JSC (xxx) xxx-xxxx	David Bannister JSC (xxx) xxx-xxxx
<b>Integrated Vehicle Assembly</b>	John Smith KSC (xxx) xxx-xxxx			Leslie Dearn MSFC (xxx) xxx-xxxx				
<b>Integrated Vehicle Test</b>	Bill Johnson JSC (xxx) xxx-xxxx	Gail Winters JSC (xxx) xxx-xxxx	Trent Cavanaugh JSC (xxx) xxx-xxxx				Tim Johnson JSC (xxx) xxx-xxxx	
<b>Operations</b>	Sandra Evers JSC (xxx) xxx-xxxx			John Doe NESC (xxx) xxx-xxxx		Jim King JSC (xxx) xxx-xxxx	Tom Feldman JSC (xxx) xxx-xxxx	
<b>Spacecraft / Payload</b>	Robert Thompson MSFC (xxx) xxx-xxxx	Trevor Johns KSC (xxx) xxx-xxxx		John Doe NESC (xxx) xxx-xxxx				
<b>Range / Pad Safety</b>	Anne Battan KSC (xxx) xxx-xxxx		Don Knight KSC (xxx) xxx-xxxx					

# P5. Requirements Filtering



## Agency SMA Requirements

### Group III: Program Implementation

NPD 8720.1A	NPD 8710.3A
NPD 8730.2A	NPR 8735.1A
NPD 8730.1A	NPD 8730.4
NPR 8735.2	NPR 8716.X
NSS 8719.13	NSS 8719.13
NSS 1740.12	

### Group IV: Program Specific Requirements

NPD 8700.3	NPR 8705.X
NPD 8700.2	NPR 8705.3
NPR 8705.2	

### Program Specific, Supporting Requirements

NSS 8719.8	NPD 8610.23
NPD 8610.7	NPD 8610.7

### Program Specific, Implementation

...

## Program / SMA Focused Filtration

Notional Program Attributes	Yes	No
• Existing program?	✓	
• Manned?		✓
• Payload?	✓	
• EAV?		✓
• ELV?	✓	
• Orbital?	✓	
• Hydrogen?		✓
• ...		

## Program-specific SMA Requirements

### Group III: Program Implementation

NPD 8720.1A	NPD 8710.3A
NPD 8730.2A	NPR 8735.1A
NPD 8730.1A	NPD 8730.4
NPR 8735.2	NPR 8716.X
NSS 8719.13	NSS 8719.13
<del>NSS 1740.12</del>	

### Group IV: Program Specific Requirements

NPD 8700.3	NPR 8705.X
<del>NPD 8700.2</del>	<del>NPR 8705.3</del>
<del>NPR 8705.2</del>	

### Program Specific, Supporting Requirements

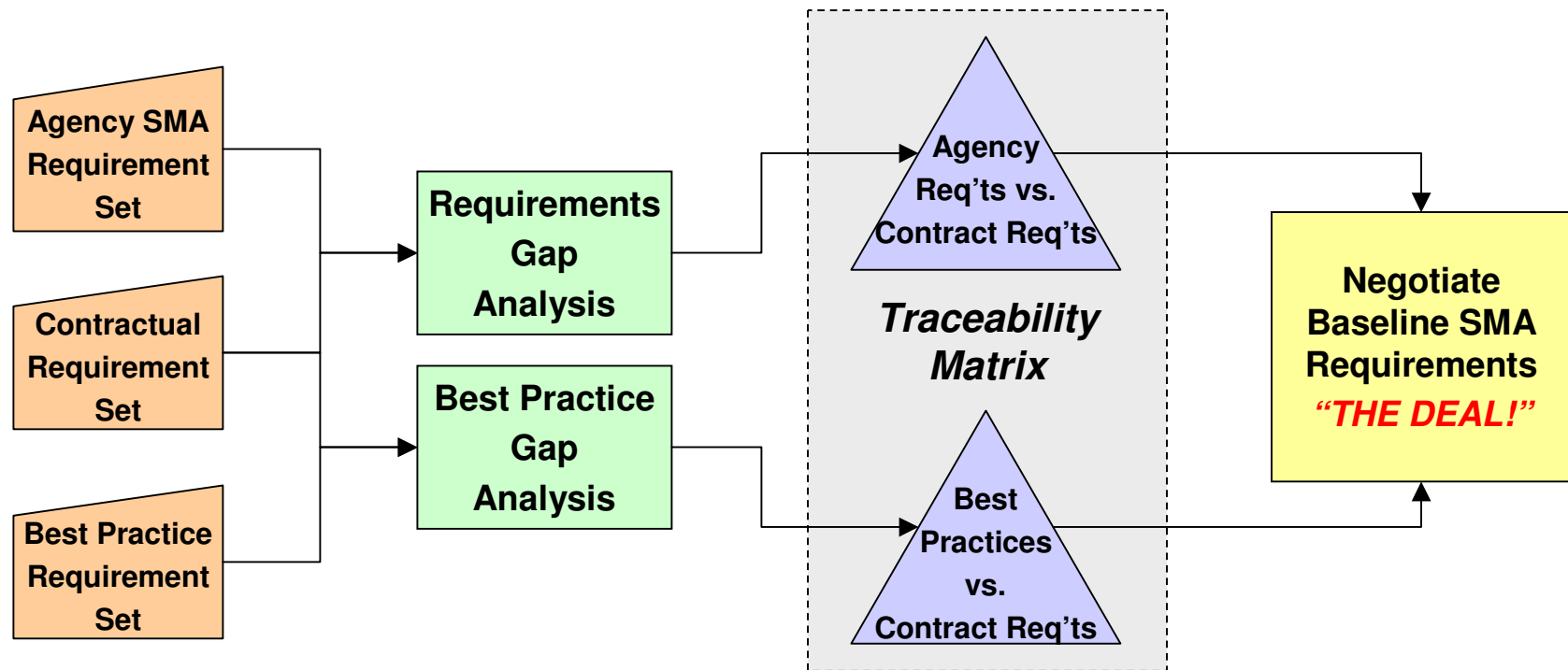
NSS 8719.8	NPD 8610.23
NPD 8610.7	NPD 8610.7

### Program Specific, Implementation

...



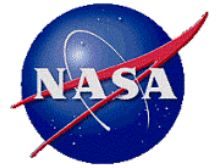
## P6. Gap Analysis



- Identify missing, redundant or additional requirements
  - Review delta requirements and Best Practices for applicability to Program
    - Inclusion requires negotiation with Program Management
  - Review additional Program requirements / Best Practices for applicability to
    - Include improvements in Agency SMA Requirement Set



# P7. Baseline Requirements

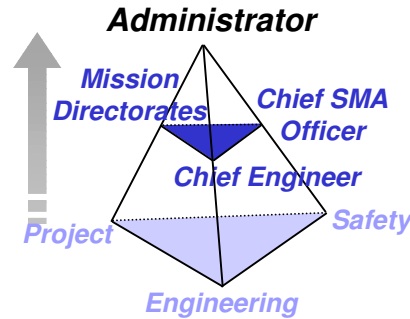
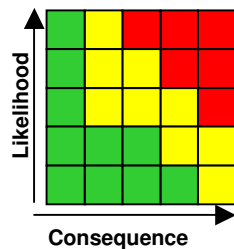


## Existing Programs

### Gap Analysis Traceability Matrix

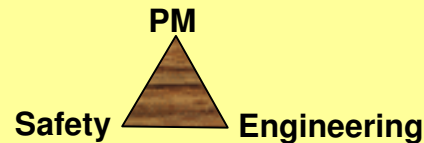
Requirement ID	Requirement Description	Requirement Source	Requirement Status	Requirement Owner	Requirement Review Date
R1001	Human Rating NPR 8705.2	Human Rating	Open	Human Rating	2010-01-01
R1002	Range Safety NPR 8716.X	Range Safety	Open	Range Safety	2010-01-01
R1003	Orbital Debris NPD 8710.3A	Orbital Debris	Open	Orbital Debris	2010-01-01
R1004	Reliability NPD 8720.1A	Reliability	Open	Reliability	2010-01-01
R1005	Human Rating NPR 8705.2	Human Rating	Open	Human Rating	2010-01-01
R1006	Range Safety NPR 8716.X	Range Safety	Open	Range Safety	2010-01-01
R1007	Orbital Debris NPD 8710.3A	Orbital Debris	Open	Orbital Debris	2010-01-01
R1008	Reliability NPD 8720.1A	Reliability	Open	Reliability	2010-01-01
R1009	Human Rating NPR 8705.2	Human Rating	Open	Human Rating	2010-01-01
R1010	Range Safety NPR 8716.X	Range Safety	Open	Range Safety	2010-01-01
R1011	Orbital Debris NPD 8710.3A	Orbital Debris	Open	Orbital Debris	2010-01-01
R1012	Reliability NPD 8720.1A	Reliability	Open	Reliability	2010-01-01

### OSMA Risk Assessment



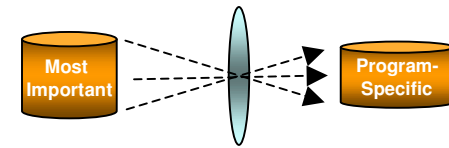
### Escalation (if required)

### Baseline Negotiation

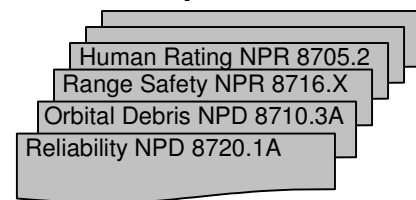


## New Programs

### Requirements Filtering



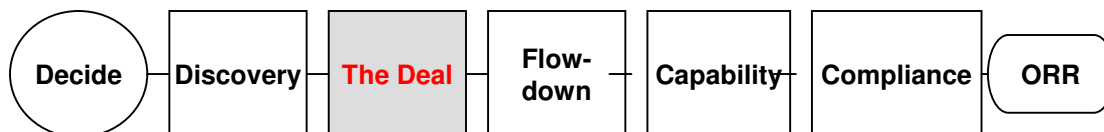
### SMA Program-specific Requirements



### "THE DEAL"

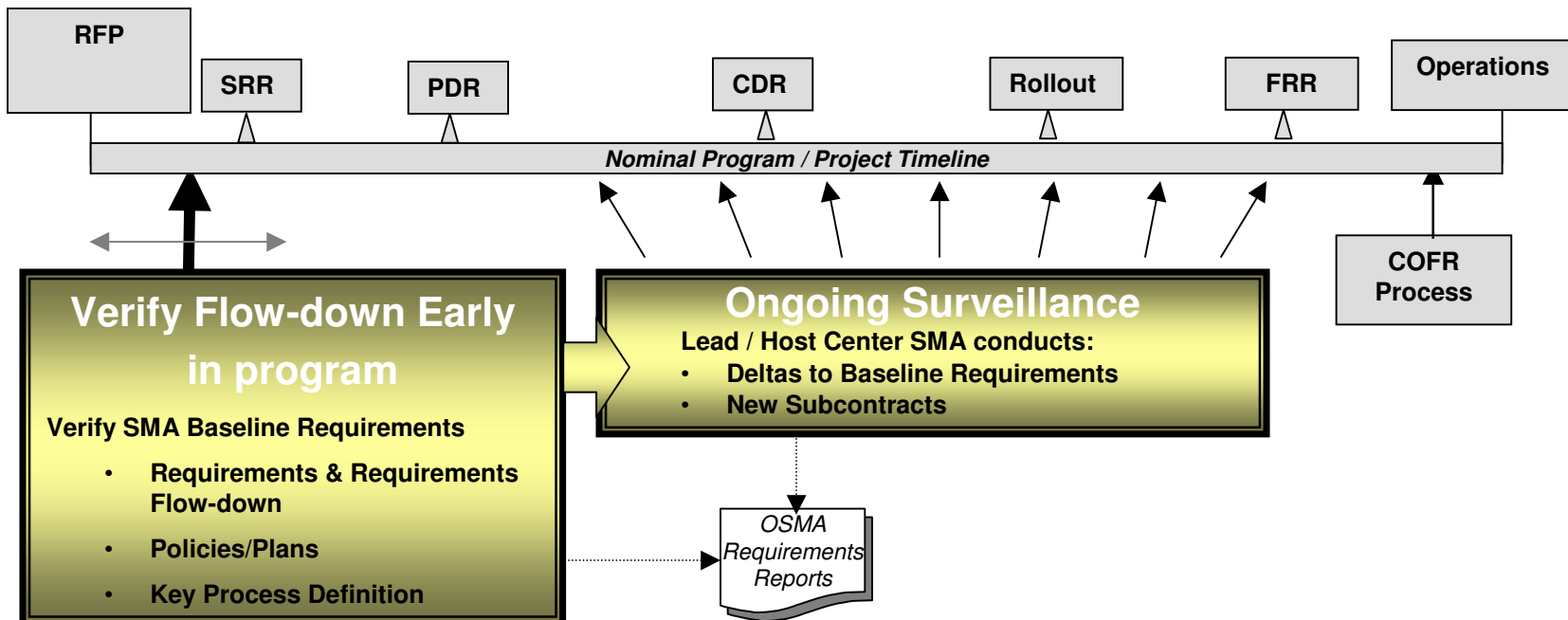
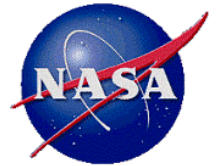
Baseline SMA Requirements Agreement

Minimized Residual Risks

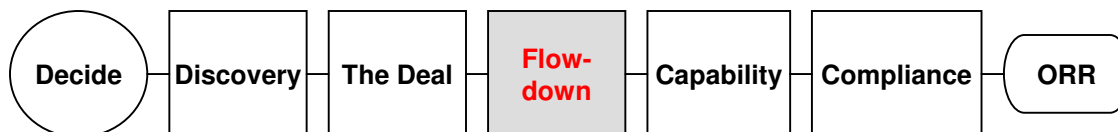




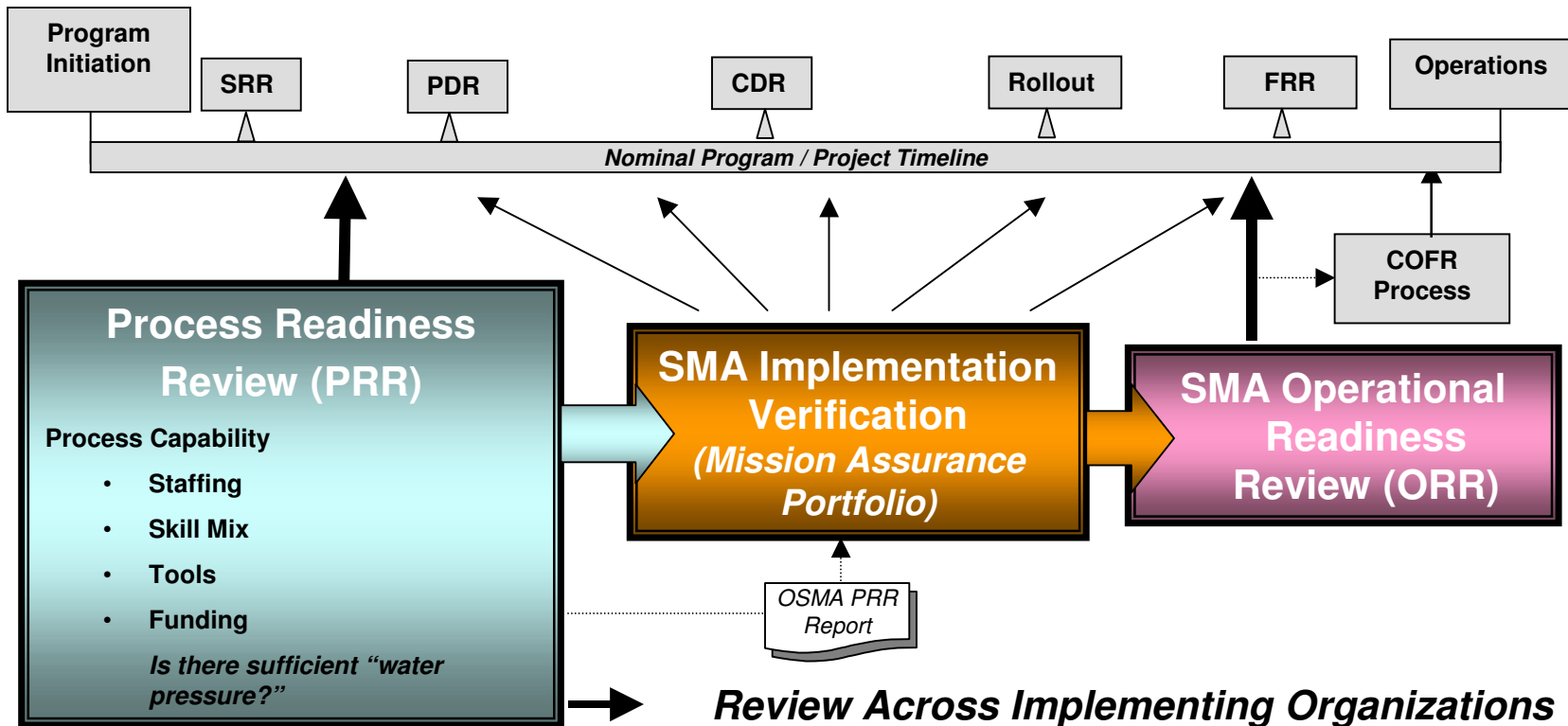
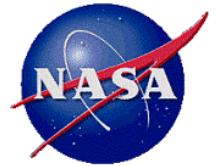
# P8. Verify Requirements Flow-Down



- Verify requirements “Flow Down” through tiered specifications as outlined in the Program/Project Plans.
- Verify derived requirements by:
  - Apportionment - portioning of whole requirement to lower levels
  - Equivalence – same value as parent requirement
  - Synthesis – derived requirement via analysis



# P9. Process Readiness Review

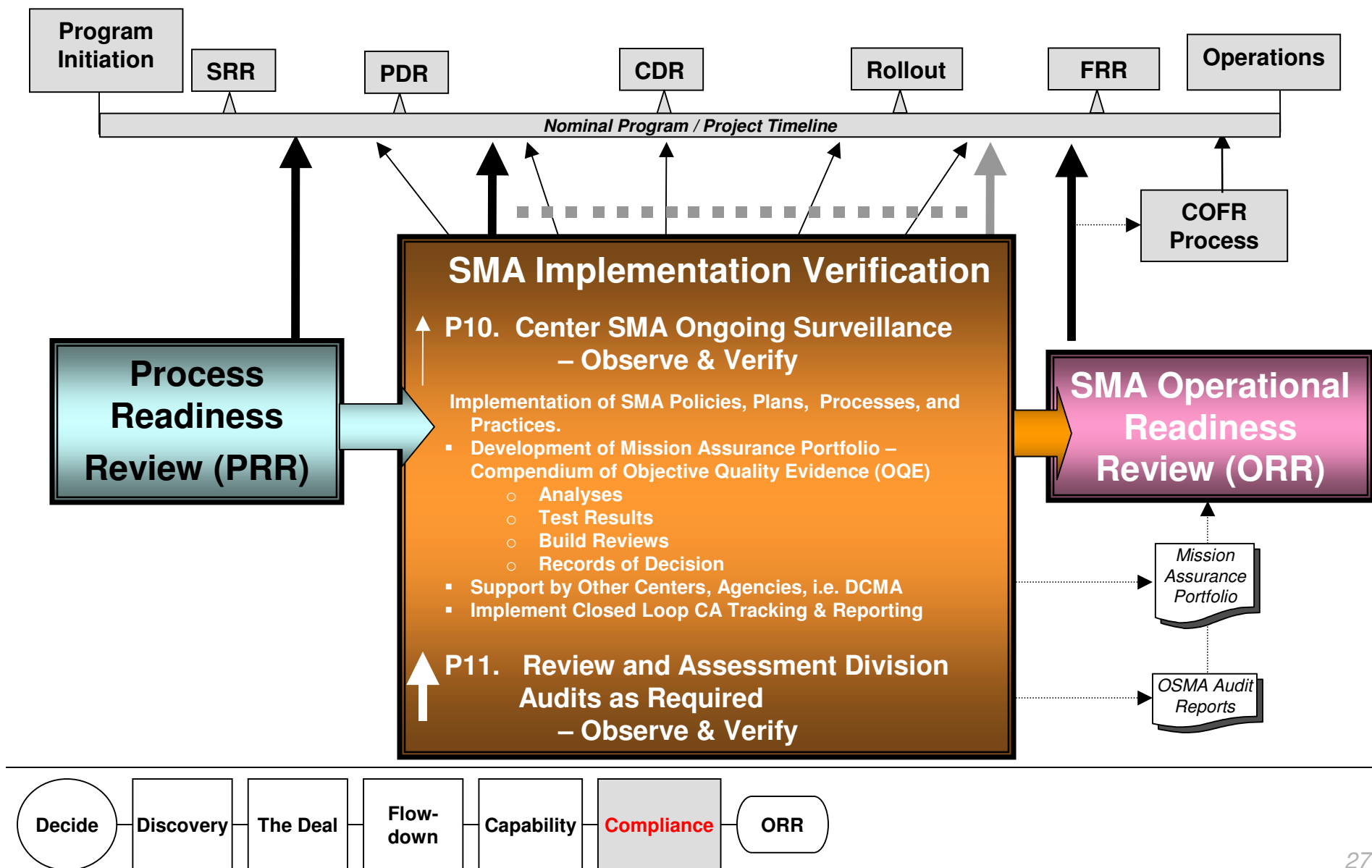
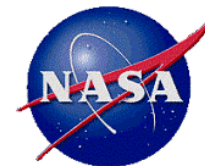


## Review Across Implementing Organizations

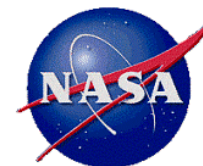
	Enterprise	Program	Project	Contract MOUs	IO	IO	IO	IO	IO
Example (Based on OSP 2002 Structure) →	•HQ/R	•OSP PM •At MSFC	•OSRUSC •OSPKSC •OSRLARC	•Multiple	•Boeing	•LM	•Orbital	•EAFB •WSTF •CCAFS	•ARC
Example (Based on GRACE Structure) →	•HQ/Y	•GSFC	•JPL	•Multiple	•ESA •S/C	•Russia •Launch •Service			



# P10&11. Compliance Verification



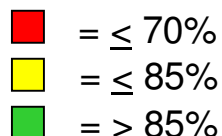
# P12. Programmatic Audit & Review Input to ORR



## Requirements Baseline & Audit/Review Findings

Management & Leadership					
1. SMA Policy					
Rqmt	OQE	PTs	WT	Score	
a. Sample data	yes	25	30	7.5	
b. Sample data	yes	25	30	7.5	
c. Sample data	no	3	10	0.3	
d. Sample data	yes	25	30	7.5	
				91.2	
2. Orbital Debris					
Rqmt	OQE	PTs	WT	Score	
a. Sample data	yes	33	40	13.3	
b. Sample data	yes	25	40	10.0	
c. Sample data	yes	33	10	6.7	
				90.0	
Core					
Verification					

## OQE Score



## Compliance Matrix

Audit Area	Implementation Organization			
	EAA	Prog.	Proj.	IO <sub>1</sub>
1. L&M	Green	Green	Green	Yellow
2. Core	Yellow	Green	Red	Green
3. Ver.	Red	Green	Yellow	Red

## Programmatic Audit and Review Risk Assessment

**RISK TYPE:** Safety or Mission Success  
**HAZARD REPORT:** Hazard Report Number  
**CRITICALITY:** Criticality Designation (I, II, III, IV)  
**RISK CATEGORY:** Technical, Changes, or Requirements  
**ORGANIZATION:** Responsible Organization  
**ASSIGNED TO:** Name and Location of Presenter  
**INDEPENDENT ASSESSORS:** Independent Assessors / Alternate Opinions

**RISK DESCRIPTION:** Description of the issue / risk  
**CAUSE:** Cause or causes which could lead to the risk event  
**RISK EFFECTS:** Consequences of the risk event  
**RISK REDUCTION ACTIONS:** Actions taken to reduce the risk associated with this issue  
**CONSTRAINTS TO FLIGHT:** Assessment as to whether this risk currently poses a constraint to flight, or could possibly do so in the future  
**RECOMMENDATION:** Recommendation to accept or not accept this risk, including a summary of the rationale which led to this conclusion

**SAFETY RISKS**  
 A: Alternate Opinion #1  
 B: Alternate Opinion #2  
 C: Alternate Opinion #3

## ORR Risk Summary

Assurance Elements	Program	Center	S&MA	NESC	PA&R	..
SMA Req. Compliance	0	0	1	3	-	-
Changes	0	0	-	-	-	-
Technical Issues	1	1	5	-	-	-

## Using Program's Risk Matrix & Risk Definitions

- Likelihood
- Consequence

